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Captain W. H. Smyth, R.N., President, in the Chair.

The following communications were read:—

I. On a Direct Method of determining the Distance of a Comet by Three Observations. By J. J. Waterston, Esq.

The following is the author's explanation of his method:—

"It is well known that three observations of a comet afford sufficient data for computing its distance from the earth independently of any assumption as to the orbit in which it moves. The formula is, I believe, originally due to Lambert, and appears in the works of the principal mathematicians who have given analytical solutions of the problem by the differential method. It is unfortunate that the nature of the equation does not admit of much precision in the results of the calculation, which are consequently apt to be greatly affected by small errors of observation. The disturbing power of these unavoidable inaccuracies varies much according to the conditions of the problem, and it is, perhaps, impossible to recognise it in the analytical expression without a much greater effort of the attention than can be given when merely computing an orbit. With good observations the method has the advantage of revealing any obvious tendency to an ellipse or hyperbola; and, besides, it will in most cases afford a useful approximation to begin with in computing the parabolic formulæ. As to the expediency of putting the observations to this preliminary test in all cases, there would, perhaps, be little difference of opinion, if the labour of computation in doing so were available in the last part of the process, and if the conditions upon which the degree of accuracy depends could be easily distinguished.

"The object of this paper is to submit to the Astronomical Society an account of a method which has occurred to me of solving

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the equation by means of a constant curve, and to shew how the preliminary calculation may be made available in Olbers' parabolic method, and likewise in a differential method, without requiring the original equatoreal position in either case to be transferred to the ecliptic. The conditions of accuracy also become so apparent in using this curve, that the effect of an error of right ascension or declination may be estimated by inspection.

"The method of solution is derived from the projection of the three observations on the plane perpendicular to the direction of the motion of the comet at the middle epoch. The earth's orbit being projected, its deflection, caused by the sun's attraction, is brought into view, and since its apparent direction is the same as that of the sun, and the projected direction of the sun from the comet is the same as at the earth, the radii vectores of both being identical on the projection; it is clear if the differentials at the middle time are alone considered that the deflection of the orbit of the comet, as it appears on the plane of projection, coincides in direction with the projected deflection of the earth's orbit and that its magnitude depends on a function of the angle at the comet. We thus obtain the means of forming an equation for the angle at the comet in terms of the deflection of the earth's orbit; and this equation, although derived from a simple geometrical construction, appears to be similar to that which is given in the analytical discussion of the problem by Laplace, Lagrange, Legendre, and Airy. It depends wholly on the effect of the sun's centripetal force during the elapsed time as it appears on the plane of projection; and, as this, in the short differential period of a few days, bears but a small proportion to the projection of its chord, or velocity, the results are much more liable to be affected by the unavoidable errors of observation than if the equation expressed the same unknown quantity in terms of the velocity. But in the last case we have to suppose the nature of the conic section known, in the first no assumption of the kind is required, the deflecting effect of the sun's force being necessarily the same in all orbits at the same central distance.

"The equation for the angle at the comet is solved by drawing one line on the constant curve, and the preliminary computation required to do so affords an expression for the ratio of the distances at the first and third observations on the usual assumption that the chord is divided in the ratio of the times.

"This expression may be converted into the elegant form given by Olbers, so that it is identical with the value of M in his formulæ, and is expressed in terms that are likewise required in drawing the line on the constant curve.

"An example is given from the Trevandrum observations of the great comet of 1843. The formulæ are also applied to Göttinger's observations of the second comet of 1813. A copy of the constant curve is given upon a separate sheet, and the lines of these examples drawn. The co-ordinates of the curve consist of the cotangent and cube of the sine. It is easily constructed by the common tables. If drawn with ordinary care, it will give the reading of the angle at

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the comet to greater nicety than even the best observations can afford.

"I have appended a modification of Olbers' formulæ for the radii vectores and chord adapted to equatoreal positions, and involving the use of the angular quantities already computed for the use of the constant curve. The additional work of computation does not appear to be so great as that which is required to convert the right ascension and declination into latitude and longitude; and, besides, it is easier to compare observations with the computed elements when the latter are referred to the equator. The inclination of the orbit and position of the nodes are transferred to the ecliptic by the solution of one spherical triangle.

"In the recent improvements which Olbers has made in his method, by expanding Euler's formula into a series and reversing, the means are afforded of constructing a small table which shortens considerably the process of finding the distance by trial and error. Another improvement consists in the new expression given for the chord being more favourable to accurate computation. I have included a form of the same kind in terms of the right ascension and declination which is almost wholly made up of angular quantities that have already been prepared and used with the constant curve.

"In the last part of the paper an expression for the angle at the comet is given to be used with the differential method which, in solving by trial and error, requires only five tabular references."

II. On the Longitude of the Observatory at Hartwell House, Buckinghamshire, from Observations of Moon-Culminating Stars. By John Glaisher, Esq.

The observations were made in consequence of the longitude hitherto assumed differing considerably from that given by the Trigonometrical Survey.

The places of the stars given in the moon-culminating list of the *Nautical Almanac* have been generally used, and the result will, therefore, require some corrections, depending on the errors of their tabular right ascensions. The extreme difference of forty-two partial results is 19^s, and it is, therefore, probable that the mean of all, viz. $2^m\ 56^s{\cdot}60$ west, is very near the truth.

III. Collection of Results from East Indian Observations of the Great Comet of 1844–5 (Wilmot's). By W. Pole, Esq.

The comet was observed at three observatories in India, viz. at Bombay, Madras, and Trevandrum. The first of these is under the direction of Professor Oclebar, but the observations were made by native assistants; the Madras observations were made by Mr. Taylor; and those at Trevandrum by Mr. Caldecott. Isolated observations were also made at sea by Captain Drinkwater Bethune, C.B., and by Captain Young, I.N.; and at Bombay by Mr. Waterston, the Astronomical Instructor to the Indian Navy, and by the author.